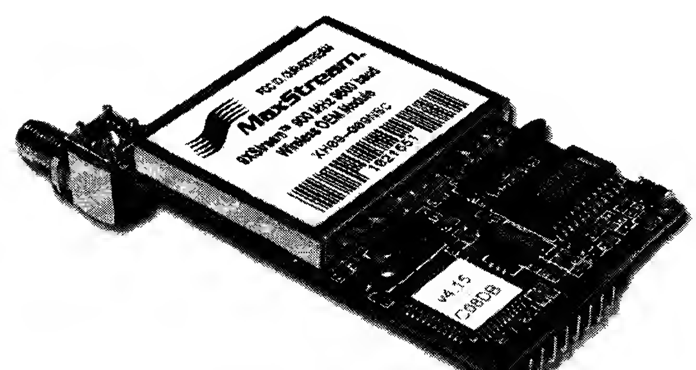
MaxStream™
Smart, wireless connections™

XStream™ 900 MHz & 2.4 GHz Wireless OEM Modules

OEM Manual

06-15-02



(actual size)

MaxStream, Inc.
1215 South 1680 West • Orem, Utah 84058
(801) 765-9885 phone • (801) 765-9895 fax
support@maxstream.net • www.maxstream.net

Table of Contents

9XStream FCC Compliance

FCC NOTICE

WARNING: This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference and (2) this device must accept any interference received, including interference that may cause undesired operation.

LABELING REQUIREMENTS

WARNING: The Original Equipment Manufacturer (OEM) must -ensure that FCC labeling requirements are met. This includes a clearly visible label on the outside of the OEM enclosure specifying "Contains Transmitter Module, FCC ID: OUR-9XSTREAM as well as the FCC Notice above.

ANTENNA WARNING

WARNING: The Original Equipment Manufacturer (OEM) must ensure that FCC labeling requirements are met. This includes a clearly visible label on the outside of the OEM enclosure specifying "Contains Transmitter Module, FCC ID: OUR-9XSTREAM as well as the FCC Notice above.

FCC Qualifications

IMPORTANT: **The 9XSTREAM module has been certified by the FCC for integration into OEM products without any further certification (as per FCC section 2.1091.) Changes or modifications not expressly approved by MaxStream could void the user's authority to operate the equipment.**

In order to fulfill the certification requirements, however, the OEM must comply with FCC regulations:

1. The system integrator must ensure that the external label provided with this device is placed on the outside of the final product.
2. The 9XStream may be used only with Approved Antennas that have been tested with this module.

9XStream Approved Antenna List

with Antenna Separation Distances for complaince with FCC Expsosure Requirements

Manufacturer	Part Number	Type	Gain	Application	Minimum Separation Distance
MaxStream	A09-Y6	Yagi	6.2dBi	Fixed/Mobile	20cm
MaxStream	A09-Y7	Yagi	7.2dBi	Fixed/Mobile	20cm
MaxStream	A09-Y8	Yagi	8.2dBi	Fixed/Mobile	20cm
MaxStream	A09-Y9	Yagi	9.2dBi	Fixed/Mobile	20cm
MaxStream	A09-Y10	Yagi	10.2dBi	Fixed/Mobile	20cm
MaxStream	A09-Y11	Yagi	11.2dBi	Fixed/Mobile	20cm
MaxStream	A09-Y12	Yagi	12.2dBi	Fixed/Mobile	20cm
MaxStream	A09-Y13	Yagi	13.2dBi	Fixed/Mobile	20cm
MaxStream	A09-Y14	Yagi	14.2dBi	Fixed/Mobile	20cm
MaxStream	A09-Y15	Yagi	15.2dBi	Fixed/Mobile	20cm
MaxStream	A09-F2	Omni Direct.	2.2dBi	Fixed	20cm
MaxStream	A09-F5	Omni Direct.	5.2dBi	Fixed	20cm
MaxStream	A09-F8	Omni Direct.	8.2dBi	Fixed	20cm
MaxStream	A09-F9	Omni Direct.	9.2dBi	Fixed	20cm
MaxStream	A09-W7	Omni Direct.	7.2dBi	Fixed	20cm
MaxStream	A09-M7	Omni Direct.	7.2dBi	Fixed	20cm
MaxStream	A09-H	1/2 wave antenna	2.1dBi	Fixed/Mobile	20cm
MaxStream	A09-HBMM-P6I	1/2 wave antenna	2.1dBi	Portable	1cm
MaxStream	A09-QBMM-P6I	1/4 wave antenna	1.9 dBi	Portable	1cm
MaxStream	A09-QI	1/4 wave integrated wire antenna	1.9 dBi	Portable	1cm

RF Exposure

⚠ WARNING: **This equipment is approved for mobile, base station and portable applications.** When using the 9XStream with mobile or base station antennas, a minimum separation distances of 20 centimeters or more should be maintained. For portable applications, refer to the minimum separation distances in the Approved Antenna list. To ensure compliance, operation at distances closer than this is not recommended. The preceding statement must be included as a CAUTION statement in manuals for OEM products to alert users on FCC RF Exposure compliance.

9XStream Warranty

The 9XStream module from MaxStream (the "Product") is warranted against defects in materials and manufacturing under normal use in accordance with instructions and specifications published by MaxStream in connection with its Development Kits or as otherwise published by MaxStream from time to time, for a period of 90 days from the date of purchase from MaxStream. In the event of a product failure due to materials or workmanship, MaxStream will repair or replace the defective product. For warranty servicc, return the defective product to MaxStream, shipping prepaid, for prompt repair or replacement.

The foregoing sets forth the full extent of MaxStream's warranties regarding the Product. Repair or replacement at MaxStream's option is the exclusive remedy. THIS WARRANTY IS GIVEN IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, AND MAXSTREAM SPECIFICALLY DISCLAIMS ALL WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT SHALL MAXSTREAM, ITS SUPPLIERS OR LICENSORS BE LIABLE FOR DAMAGES IN EXCESS OF THE PURCHASE PRICE OF THE PRODUCT, FOR ANY LOSS OF USE, LOSS OF TIME, INCONVENIENCE, COMMERCIAL LOSS, LOST PROFITS OR SAVINGS, OR OTHER INCIDENTAL, SPECIAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF THE USE OR INABILITY TO USE THE PRODUCT, TO THE FULL EXTENT SUCH MAY BE DISCLAIMED BY LAW. SOME STATES DO NOT ALLOW THE EXCLUSION OR LIMITATION OF INCIDENTAL OR CONSEQUENTIAL DAMAGES. THEREFOR, THE FOREGOING EXCLUSIONS MAY NOT APPLY IN ALL CASES. This warranty provides specific legal rights. Other rights which vary from state to state may also apply.

24XStream FCC Compliance

FCC Notice

WARNING: This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference and (2) this device must accept any interference received, including interference that may cause undesired operation.

Labeling Requirements

WARNING: The Original Equipment Manufacturer (OEM) must -ensure that FCC labeling requirements are met. This includes a clearly visible label on the outside of the OEM enclosure specifying "Contains Transmitter Module, FCC ID: OUR-24XSTREAM" as well as the FCC Notice above.

Antenna Warning

WARNING: This device has been tested with Reverse Polarity SMA and MMCX connectors with the antennas listed below. When integrated in the OEMs product, these fixed antennas require installation preventing end-users from replacing them with non-approved antennas. Any antenna not in the following table must be tested to comply with FCC Section 15.203 for unique antenna connectors and Section 15.247 for emissions.

IMPORTANT: **The 24XSTREAM module has been certified by the FCC for integration into OEM products without any further certification (as per FCC section 2.1091.) Changes or modifications not expressly approved by MaxStream could void the user's authority to operate the equipment.**

In order to fulfill the certification requirements, however, the OEM must comply with FCC regulations:

1. The system integrator must ensure that the external label provided with this device is placed on the outside of the final product.
2. The 24XStream may be used only with **Approved Antennas** that have been tested with this module.

24XStream Approved Antenna List

with Antenna Separation Distances for complaince with FCC Exposure Requirements

Manufacturer	Part Number	Type	Gain	Application	Minimum Separation Distance
MaxStream	A24-Y6	Yagi	6dBi	Fixed	2m
MaxStream	A24-Y8	Yagi	8.8dBi	Fixed	2m
MaxStream	A24-Y9	Yagi	9dBi	Fixed	2m
MaxStream	A24-Y10	Yagi	10dBi	Fixed	2m
MaxStream	A24-Y11	Yagi	11dBi	Fixed	2m
MaxStream	A24-Y12	Yagi	12dBi	Fixed	2m
MaxStream	A24-Y12	Yagi	12.5dBi	Fixed	2m
MaxStream	A24-Y13	Yagi	13.5dBi	Fixed	2m
MaxStream	A24-Y15	Yagi	15dBi	Fixed	2m
MaxStream	A24-F2	Omni Direct.	2.1dBi	Portable/Mobile/Fixed	20cm
MaxStream	A24-F3	Omni Direct.	3dBi	Portable/Mobile/Fixed	20cm
MaxStream	A24-F5	Omni Direct.	5dBi	Portable/Mobile/Fixed	20cm
MaxStream	A24-F7	Omni Direct.	7.2dBi	Fixed	2m
MaxStream	A24-F8	Omni Direct.	8dBi	Fixed	2m
MaxStream	A24-F9	Omni Direct.	9.5dBi	Fixed	2m
MaxStream	A24-F10	Omni Direct.	10dBi	Fixed	2m
MaxStream	A24-F12	Omni Direct.	12dBi	Fixed	2m
MaxStream	A24-F15	Omni Direct.	15dBi	Fixed	2m
MaxStream	A24-P8	Panel	8.5dBi	Fixed	2m
MaxStream	A24-P13	Panel	13dBi	Fixed	2m
MaxStream	A24-P14	Panel	14dBi	Fixed	2m
MaxStream	A24-P15	Panel	15dBi	Fixed	2m
MaxStream	A24-P16	Panel	16dBi	Fixed	2m
MaxStream	A24-P19	Panel	19dBi	Fixed	2m
MaxStream	A24-HABMM-P6I	Dipole	2.1dBi	Portable/Mobile/Fixed	20cm
MaxStream	A24-HBMM-P6I	Dipole	2.1dBi	Portable/Mobile/Fixed	20cm
MaxStream	A24-HABSM	Dipole	2.1 dBi	Portable/Mobile/Fixed	20cm
MaxStream	A24-QABMM-P6I	Monopole	1.9 dBi	Portable/Mobile/Fixed	20cm
MaxStream	A24-QBMM-P6I	Monopole	1.9 dBi	Portable/Mobile/Fixed	20cm
MaxStream	A24-QI	Monopole	1.9 dBi	Portable/Mobile/Fixed	20cm

RF EXPOSURE

⚠ **WARNING: This equipment is approved only for mobile and base station transmitting devices**, separation distances of (i) 20 centimeters or more for antennas with gains < 6 dBi or (ii) 2 meters or more for antennas with gains ≥ 6 dBi should be maintained between the antenna of this device and persons during operation. To ensure compliance, operation at distances closer than this is not recommended.

The preceding statement must be included as a CAUTION statement in manuals for OEM products to alert users on FCC RF Exposure compliance.

24XStream Warranty

The 24XStream module from MaxStream (the "Product") is warranted against defects in materials and manufacturing under normal use in accordance with instructions and specifications published by MaxStream in connection with its Development Kits or as otherwise published by MaxStream from time to time, for a period of 90 days from the date of purchase from MaxStream. In the event of a product failure due to materials or workmanship, MaxStream will repair or replace the defective product. For warranty service, return the defective product to MaxStream, shipping prepaid, for prompt repair or replacement.

The foregoing sets forth the full extent of MaxStream's warranties regarding the Product. Repair or replacement at MaxStream's option is the exclusive remedy. THIS WARRANTY IS GIVEN IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, AND MAXSTREAM SPECIFICALLY DISCLAIMS ALL WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT SHALL MAXSTREAM, ITS SUPPLIERS OR LICENSORS BE LIABLE FOR DAMAGES IN EXCESS OF THE PURCHASE PRICE OF THE PRODUCT, FOR ANY LOSS OF USE, LOSS OF TIME, INCONVENIENCE, COMMERCIAL LOSS, LOST PROFITS OR SAVINGS, OR OTHER INCIDENTAL, SPECIAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF THE USE OR INABILITY TO USE THE PRODUCT, TO THE FULL EXTENT SUCH MAY BE DISCLAIMED BY LAW. SOME STATES DO NOT ALLOW THE EXCLUSION OR LIMITATION OF INCIDENTAL OR CONSEQUENTIAL DAMAGES. THEREFOR, THE FOREGOING EXCLUSIONS MAY NOT APPLY IN ALL CASES. This warranty provides specific legal rights. Other rights which vary from state to state may also apply.

Overview

The 9XStream and 24XStream modules are frequency-hopping wireless modules that allow wireless communication between equipment using a standard asynchronous serial data stream. The half-duplex transmission of the XStream can sustain a continuous data stream at the specified data rate.

The XStream has been engineered for use with the following applications (among others):

- Supervisory Control and Data Acquisition (SCADA)
- Remote meter reading
- Home Automation
- Security
- Instrument monitoring
- Point of Sale Systems (POS)

The XStream operates within its respective ISM Band and is approved by the FCC under Part 15 of FCC Rules and Regulations. A regulated 5-volt supply is required for operation.

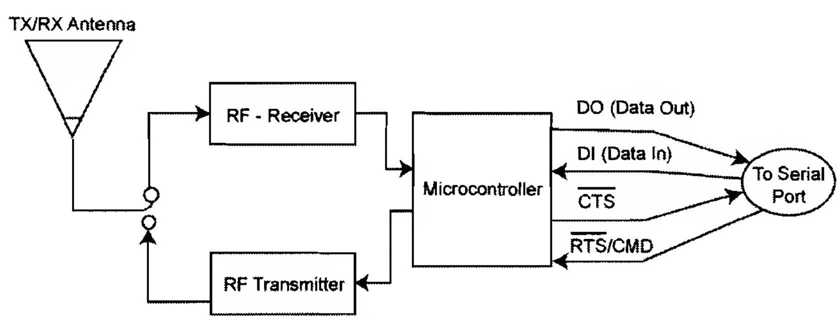


Figure 1a - Block diagram demonstrating basic module operation and data flow for both transmit and receive.

Features

- Frequency-Hopping Spread Spectrum (FHSS) technology
- Noise and interference resistance
- Enhanced sensitivity and range
- Multiple Low-power modes (down to 1 Microamp)
- Standard serial digital interface connection
- Built-in Networking and addressing
- Simple AT command interface
- 9600 and 19200 baud transfer rates available
- Packet retries and acknowledgements

Simple Product Integration

The XStream module requires no knowledge of radio frequency (RF) design. It interfaces to any UART or PC Serial Port using the MaxStream interface board and has been developed with a small form-factor for ease of integration. The data transfer performance of the XStream has been enhanced with proprietary technology from MaxStream and requires no additional licensing or FCC approval.

Serial Port Operation

The XStream modules come equipped with a CMOS-level asynchronous serial port. Through this serial port, the XStream module can communicate directly with any device having a UART interface, or with an RS-232 or RS-485/422 device via the MaxStream Interface Board. By connecting the XStream module to a host device's serial port, the host device becomes empowered to communicate wirelessly with ease. To transmit, the host device simply sends serial data to the XStream module, which then converts the data to spread spectrum FCC-approved wireless data. When this spread spectrum data is detected by a receiving XStream module, the data is checked for integrity and then sent to a receiving device via the serial port. This is shown in Figure 2 below. All low-asserted pins are distinguished with a horizontal line over the pin name.

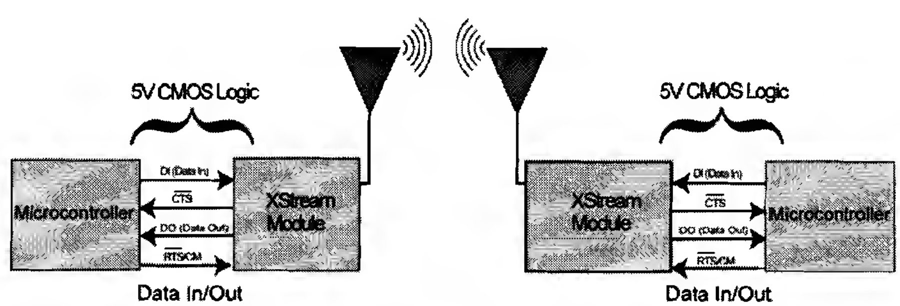


Figure 2a

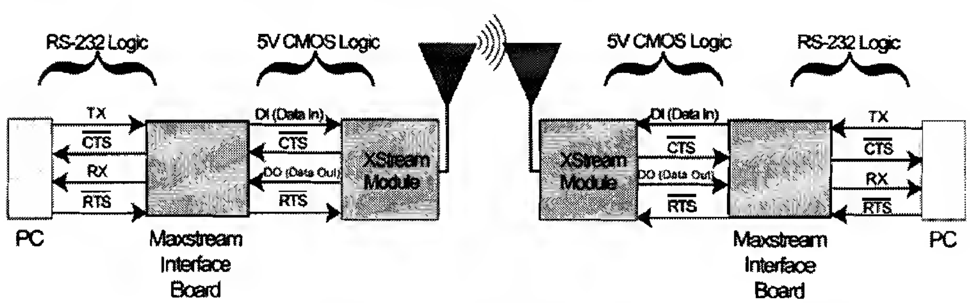


Figure 2b

Figure 2 – Diagram of data flow from a microcontroller (or any RS-232 or RS-485/422 device) through a pair of XStream wireless modules to receiving device.

Note**: When connecting the XStream to an RS-232 or RS-485/422, the MaxStream Interface Board adjusts voltage levels between the RS-232 or RS-485/422, and the MaxStream wireless module.**

Module Pins

Figure 2 shows 4 data lines needed to interface from a microcontroller or RS-232 device to the XStream modules. These four lines represent DI (Data In), DO (Data Out), CTS, and RTS/CMD (Request to Send/Command Mode). While the DI and DO pins are indispensable in almost all cases, the CTS and RTS/CMD may not be needed under certain conditions. The following includes a brief description of each of these pins and under what conditions the pins must be used. A brief explanation of the CONFIG pin is also provided.

DI (Data In) – Pin 4 (Input)

Data enters the XStream module on the DI pin as an asynchronous serial signal. The serial signal is idle (high) when no data is being transmitted. Each data packet consists of a start bit (low), 8 data bits (lcast significant bit first), and a stop bit (high). Figure 3 shows what the serial bits for number 25 Hex would look like.

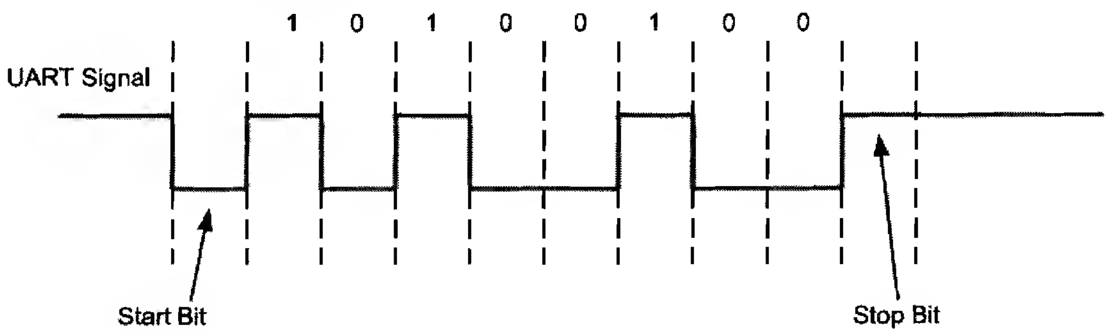


Figure 3

Figure 3 – UART data "25" (Hex) transmitted to an XStream module from a microcontroller or RS-232 device.

The XStream modules transfer exactly 8-bits over the air. The start and stop bits from the UART signal are not actually transmitted, but are regenerated on the receiving module before thcy are sent out the serial port.

DI (Data In) – Pin 4 (Input) (cont.)

Data is always received and transmitted at the serial port as a start bit, 8 data bits, and one stop bit. This allows for the following data configurations to be sent:

- 8-bit, no parity, 1 stop bit
- 7-bit, even parity, 1 stop bit
- 7-bit, odd parity, 1 stop bit
- 7-bit, no parity, 2 stop bits

Note: The 9600 and 19200-baud modules allow incoming serial data to be transferred at a rate of 2400-57600 bits/second. Serial data can be transferred to the module at a rate equal to or less than the module's over-the-air baud rate without any problems. However, if the serial interface rate is set to exceed the module's baud rate (9600 or 19200 bps respectively), flow control must be implemented since the data buffer may become full.

DO (Data Out) – Pin 3 (Output)

Data received from over-the-air transmissions is checked for errors and then sent to the DO pin.

$\overline{\text{CTS}}$ – Pin 1 (Output)

The $\overline{\text{CTS}}$ pin (clear to send) informs the host device whether or not serial data can be sent to the XStream module. When CTS is asserted (low), serial data can be sent to the XStream module. CTS is directly related to the DI Buffer for RS-232 applications. For RS-485/422 applications, the CTS signal controls the transmit driver on the RS-485/422 and RS-422 logic converters (on the MaxStream Interface Board). See the CS command in the "XStream Commands" table on page 51.

In some applications, the $\overline{\text{CTS}}$ signal may not need to be implemented. See thc "Data Buffering and Flow Control" section on page 13.

$\overline{\text{RTS}}$/CMD – Pin 5 (Input)

$\overline{\text{RTS}}$ The $\overline{\text{RTS}}$ signal can be configured to enable $\overline{\text{RTS}}$ flow control recognition or to enable binary programming on the XStream module. To configure RTS flow control or binary programming, the RT parameter must be set to the appropriate value as described in the Command Mode section and the Command Table. If RTS flow control is enabled, no data will be sent out the DO pin when RTS is de-asserted (high). By default, RTS flow control is not observed and binary programming is disabled.

CMD This pin can be used as one way to manually configure the XStream module as described in the "Command Mode" section. When this pin is driven high (asserted), incoming serial data (on the DI pin) is interpreted as commands instead of data. See the "Command Mode" section on page 21.

CONFIG – Pin 9 (Input)

When AT Command Mode cannot be entered using the normal procedure (See AT Command Mode section), the CONFIG pin (low-asserted) is used to manually enter AT Command Mode. If this pin is asserted during reset or power-up, the module will immediately enter AT Command Mode. The serial port baud rate is temporarily set to match the default baud rate of the XStream module. This ensures that the module will transition into AT Command Mode at a known baud rate. Upon entering AT Command Mode, all configured parameters, including the baud rate, remain in their saved state and can be modified as described in the "AT Commands" section on page 22.

IMPORTANT: DO NOT tie the CONFIG pin directly to the microprocessor as it may cause problems with module operation. It is recommended that the CONFIG pin be tied to an external switch and be used manually to enter AT Command Mode only when the AT Command Mode cannot be entered under the normal procedure. See the "AT Commands" section on page 22.

Data Buffering and Flow Control

Data In Buffer

All serial data that is sent to the XStream module enters on the DI pin (as described in the Module Pins section) and is stored in the Data In (DI) Buffer until it can be transmitted. The specifications for this buffer are shown in Table 1 below.

Once the first byte of data enters the DI Buffer, the module will begin to transmit the data unless RF data is being received. If the module is receiving RF data, any serial data that enters on the DI pin will be placed in the DI Buffer. When 17 bytes of empty space are left in the DI Buffer, the XStream module will de-assert (high) CTS to signal to the host device to stop sending data. CTS will assert once the DI Buffer has at least 35 bytes available. In addition to CTS flow control, XON/XOFF flow control can also be implemented on the XStream modules using the FL command. See the "XStream Commands" Table (Appendix E) on page 44. In this case, the XStream module will send the XOFF and XON signals instead of asserting/de-asserting CTS to provide flow control between the host device and the XStream module.

Data Out Buffer

All incoming RF data is received into the Data Out (DO) Buffer and then sent out the serial port to the host device. The specifications for the DO Buffer are listed in Table 1 (below). If $\overline{RTS}$ is enabled for flow control (see $\overline{RTS}$/CMD in Module Pins section), data will not be sent out of the DO Buffer when the $\overline{RTS}$/CMD pin is de-asserted (high). In such a scenario, data could be lost if RTS is de-asserted long enough to allow the DO Buffer to become full.

Product	DI Buffer Capacity	DO Buffer Capacity
9XStream	132 Bytes	132 Bytes
24XStream	132 Bytes	132 Bytes

Table 1 – Specifications for the Data Buffers on the XStream modules.

Using $\overline{CTS}$ Flow Control

If the DI Buffer reaches its capacity, either the $\overline{CTS}$ line or XON/XOFF flow control must be observed to prevent loss of data between the host device and the XStream module. There are three cases in which the DI Buffer may become full.

1. If the serial interface rate is set higher than the default baud rate for the module, the module will receive serial data faster than it is transmitted.
2. If the XStream module is receiving a continuous stream of data or monitoring data on the network, any serial data that arrives on the DI pin will be placed in the DI Buffer. This data will not be transmitted until the module no longer detects any RF data in the network.
3. If Acknowledged Delivery is enabled, the throughput will decrease and long data sequences will cause the DI Buffer to fill. See the "Acknowledged Delivery" on page 28.

Using CTS Flow Control (cont.)

If none of these scenarios apply to a particular application, the $\overline{\text{CTS}}$ flow control line is not required. Bursts of data that are shorter than the DI Buffer's capacity can usually be sent without flow control since all of the data will fit in the DI Buffer regardless of whether the data is transmitted immediately or not.

Using $\overline{\text{RTS}}$ Flow Control

If $\overline{\text{RTS}}$ flow control is implemented on the host device, the RT parameter must be set on the XStream module in order to recognize the $\overline{\text{RTS}}$/CMD signal as a flow control line. See the "RTS/CMD" section on page 11.

If $\overline{\text{RTS}}$ is asserted, all received RF data will be placed in the DO Buffer until the $\overline{\text{RTS}}$ line is de-asserted. Once the DO Buffer reaches capacity, any additional received RF data will be lost unless Acknowledged Delivery has been enabled on the modules. See "Acknowledged Delivery" on page 28 for more information.

Modes of Operation

The XStream wireless module features several modes of operation that allow the module to be flexible while saving power. The operating modes of the XStream module are shown in Figure 4 below.

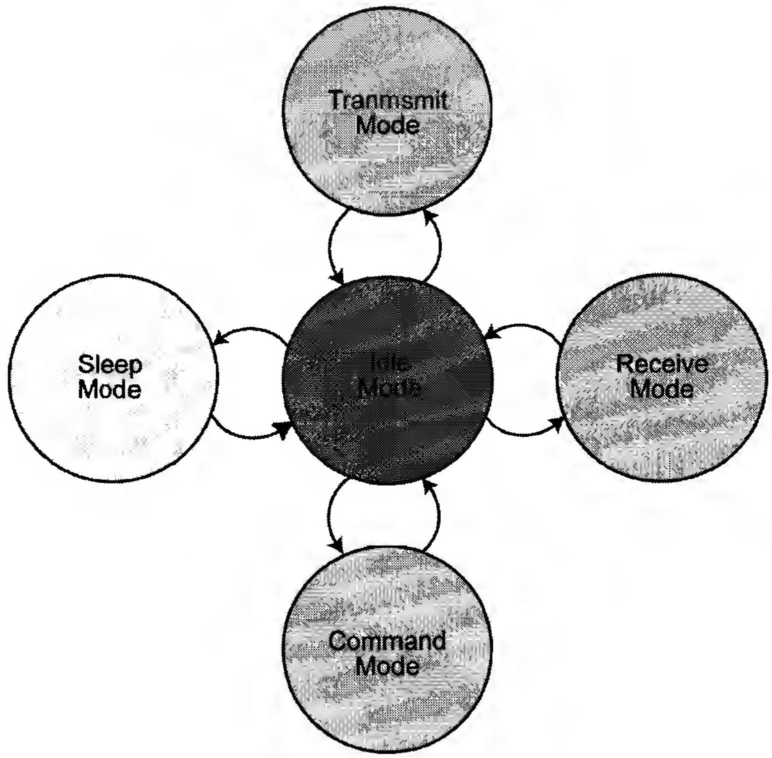


Figure 4

Idle Mode

The XStream module operates in **Idle Mode** when there is no data being transmitted or received. In Idle Mode, the module continually checks the following conditions:

1) DI Buffer received serial data.
2) Valid data received at the antenna.
3) Command Mode Entry.
4) Sleep Mode Condition.

If one of these conditions has been met, the module transitions from Idle Mode to the appropriate mode. The module will return to Idle Mode after it has finished responding to the condition.

Transmit Mode

When the first byte of serial data arrives in the DI buffer, the module exits Idle Mode and transitions to Transmit Mode. Once in Transmit Mode, the module sends out a header to initialize the communications channel and allow other modules to synchronize to the transmitter. While this header is being transmitted, incoming serial data is accumulated in the DI buffer. Once the header has been sent, the data in the DI buffer is grouped into a packet up to 64 bytes and transmitted. The module continues to transmit the data in packets until no data is in the DI buffer. Once transmission is finished, the module returns to Idle Mode. This progression is shown in Figure 5a and 5b below.

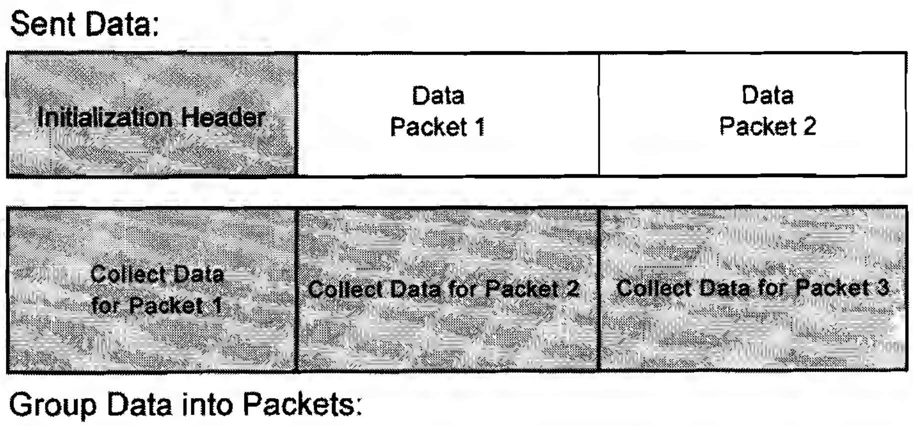


Figure 5a – Generation of data packets

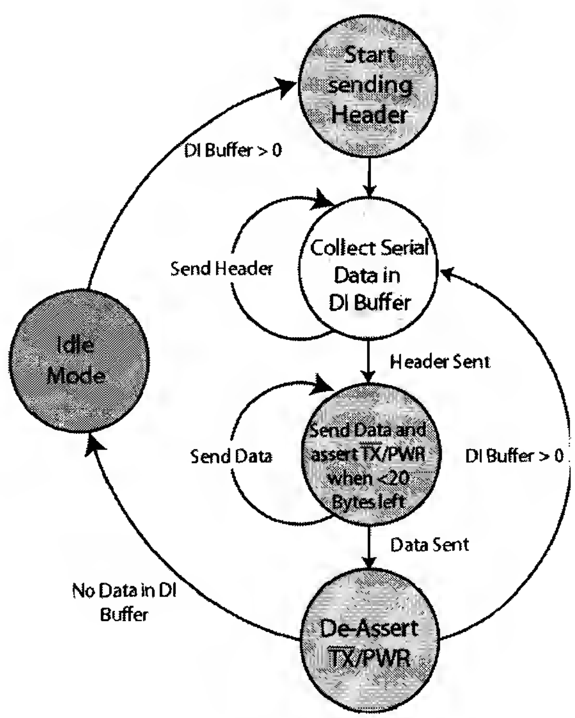


Figure 5b – Transmit Mode description

Data Validity

To verify data integrity, a 16-bit cyclic redundancy check (CRC) is computed for the transmitted data and attached to the end of each data packet before transmission. The receiver will then compute the CRC on all incoming data. Any received data that has an invalid CRC is discarded.

Transmission Latency

Transmission latency depends on the number of bytes contained in a packet and the baud rate of the module. In addition, the header is sent every time a new transmission sequence begins as shown in Figure 5b. In some applications, the SY command can be used to reduce the length of the header sent at the beginning of a transmission and thus reduce the data latency. See the Application Note, "How does the SY Command Affect Packet Transmission?" on page 36.

Receive Mode

If the module detects data when it is operating in Idle Mode, it will transition to Receive Mode and start receiving packets. Once a packet is received, it goes through a CRC (cyclic redundancy check) to ensure that the data was transmitted correctly. If the CRC data bits on the incoming packet are invalid, the packet is discarded. If the CRC is valid, the packet is put in the DO Buffer. This process is shown in Figure 6 below.

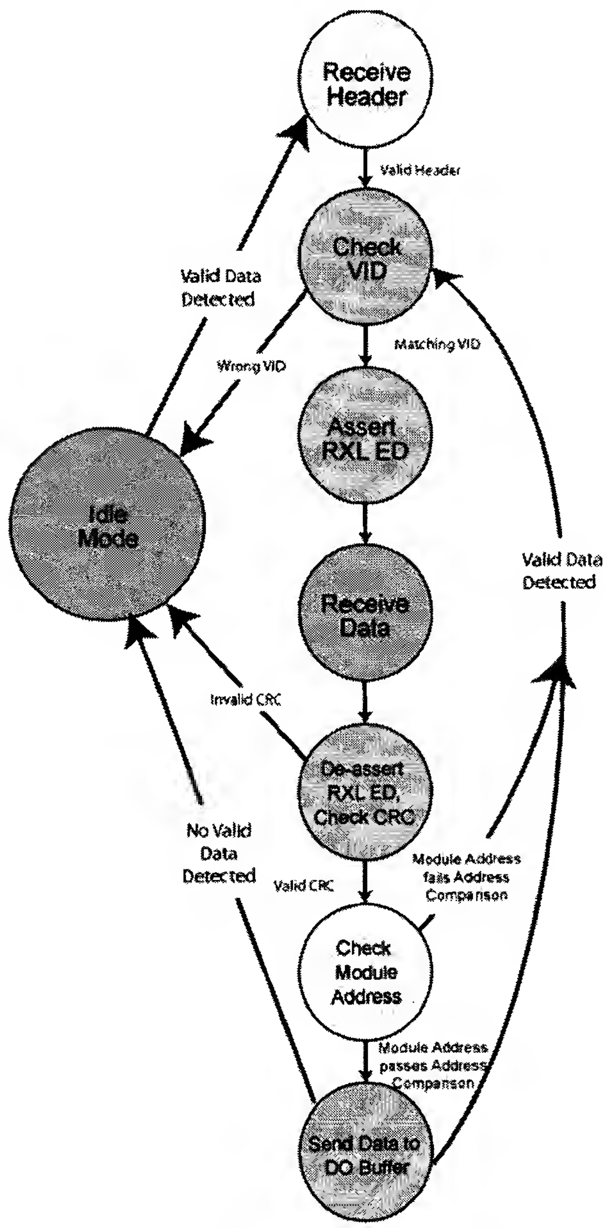


Figure 6 – Receive Mode description

Receive Mode *(cont.)*

The module will return to Idle Mode once an error is detected in thc received data or when valid data is no longer detected at the antenna. If serial data was stored in the DI buffer while the module was in Receive Mode, the data will be transmitted after the module returns to ldle Mode.

Sleep Mode

Sleep Mode enables the XStream module to go into a low-power state in which minimal power is consumed when the module is not in use. Once in Sleep Modc, the module will not transmit or receive data until it first returns to Idle Mode. To enter Sleep Mode, the module must be idle (no data transmission or reception) for a user-defined period of time. See the ST command in the "XStream Commands" table (Appendix E) on page 44 for more information. After this time elapses, the module transitions to Sleep Mode. By default, Sleep Mode is disabled and must be enabled using the SM command.

The XStream features several Sleep Mode settings, each of which makes use of different mechanisms to enter or leave Sleep Mode. The Sleep Mode table lists the various Sleep Mode settings along with sample applications and the requirements to transition to and from Sleep Mode for each setting. See the "Sleep Mode" table (Appendix H) on page 53.

Pin Sleep (SM=1)

After enabling the **Pin Sleep** setting, the Sleep pin (Pin 2) controls whether the XStream is active or in Sleep Mode. If SLEEP is de-asserted, the module is fully operational. Once SLEEP is asserted, the module transitions to Sleep Mode and remains in its lowest power consuming state until the SLEEP pin is de-asserted. The XStream requires 40 ms to transition from Sleep Mode to Idle Mode. The SLEEP pin is only active if the module is set up to operate in this mode; otherwise the pin is ignored. See the SM command in the "XStream Commands" table (Appendix E), on page 44. Once in Pin Sleep Mode, the $\overline{CTS}$ pin (Pin 1) is de-asserted (high) to indicate that data should not be sent to the module during this time. The PWR pin (Pin 8) is also de-asserted (low) when the module is in Pin Sleep Mode.

Serial Port Sleep (SM=2)

If this state is enabled, the module goes into Sleep Mode after a user-defined period of inactivity (no transmitting or receiving of data). This period of time can be changed by modifying the ST command. The module will return to Idle Mode once a character is received on the DI pin.

Cyclic Sleep (SM=3-7)

If the **Cyclic Sleep** setting is enabled, the XStream module goes into Sleep Mode after a user-defined period of inactivity (no transmission or reception on the RF channel). The user-defined period may be set by adjusting the ST parameter. See the ST command in the "XStream Commands" table (Appendix E) on page 44.

While the module is in a low-power state, the $\overline{\text{CTS}}$ pin (Pin 1) is de-asserted (high) to indicate that data should not be sent to the module during this time. When the module awakens to listen for data, the $\overline{\text{CTS}}$ pin is asserted, and any data received on the DI pin will be transmitted. The PWR pin (Pin 8) is also de-asserted (low) when the module is in Cyclic Sleep Mode. It is asserted each time the module cycles into Idle Mode to listen for valid data packets, and then de-asserts if the module returns to Sleep Mode.

The module remains in Sleep Mode for a user-defined period of time ranging from 0.5 seconds to 16 seconds (adjustable using SM command). After this period of time, the module returns to Idle Mode and listens for a valid data packet for 100 ms. If no valid data packet is found (on any channel), the module returns to Sleep Mode. If a data packet is found, the module transitions into **Receive Mode** and receives the incoming packets until another ST inactivity time out occurs.

The module can also be configured to wake up from cyclic sleep when the SLEEP pin (Pin 2) is de-asserted (low). To configure a module to operate in this manner, the PW command must be issued. See the "Command Mode" section on page 21. Once the SLEEP pin is de-asserted, the module is forced into Idle Mode and can begin transmitting or receiving data. It will remain active until no data is detected for the period of time specified by the ST parameter, at which point it resumes its low-power cyclic state.

Cyclic Scanning

Each RF packet consists of a header and data as shown previously in Figure 5a. Since the header contains the channel synchronization information, all receiver modules must wake up during the header portion of a packet in order to synchronize with the transmitter and receive the data. To ensure that the XStream module can detect the header, a long header can be sent periodically during a transmission. This long header repeats the synchronization information for a period of time defined by the LH command.

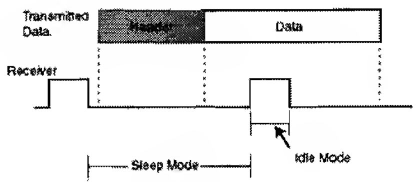


Figure 7a – The length of the long header is not as long as the period of Cyclic Sleep. It is possible for the receiver to wake and miss the header (and therefore the data packet) in this scenario.

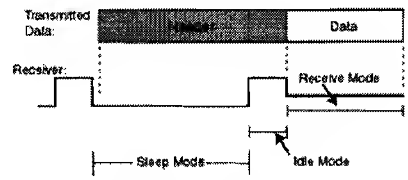


Figure 7b – The length of the long header exceeds the period of Cyclic Sleep. The receiver is guaranteed to detect the header and receive the data packet.

The long header is only sent with the initial transmitted packet after a user-defined period of inactivity (no serial data received and no over-the-air transmitting or receiving). This period of inactivity must be adjusted using the HT command. See the "XStream Commands" table (Appendix E) on page 44. Sending a long header assures that the receiver will detect the new transmission and will be able to receive the data (as long as the header length slightly exceeds the cyclic sleep time). If the sleeping module missed the long header due to interference and doesn't respond as expected, a new long header can be sent using the FH command.

Command Mode

Command Mode allows several features, including the power-down and addressing options, to be configured. These adjustable parameters offer greater flexibility to designers in configuring the module to fit specific design criteria. There are three ways to enter Command Mode:

1. Assert CMD (high) and send a binary command.
2. Send the sequence "+++" to send AT commands.
3. Assert (low) the $\overline{\text{CONFIG}}$ pin and turn the power switch off and back on.

Important: **Do not tie $\overline{\text{CONFIG}}$ pin to microprocessor. See the "Serial Port Operation" section on page 9.**

Once in Command Mode, the configurable parameters can be adjusted using either AT commands or Binary commands, as explained below. Any parameters that are changed while in Command Mode must be saved to non-volatile memory using the WR command, or they will reset to their stored value upon reset or power-up.

Command Mode *(cont.)*

In these examples, sent or received ASCII characters are marked in quotations. Quotation marks should not be included when sending commands to the XStream modules. Carriage Returns (ASCII character 13) will be denoted as <CR>. Binary values are represented in this document with < and >. These characters are also not sent as part of the actual command. All binary values are represented as hexadecimal values (HEX) in these examples, and are denoted by an H after the number. The actual Binary Command values must all be sent in binary with the Least Significant Byte (LSB) sent first followed by the Most Significant Byte (MSB) if the value is larger than one byte.

AT Commands

The following sections contain a description of the AT and Binary Command Modes along with some examples. In these examples, sent or received ASCII characters are marked in quotations.

AT commands can be sent to the module using ASCII commands and parameters. A special break sequence is used so that the module will transition into AT Command Mode. The default sequence for entering AT Command Mode is as follows:

- No characters sent for one (1) second.
  (Time modified by BT command.)
- Three (3) plus characters (+++) sent within one (1) second.
  (Character modified by CC command.)
- No characters sent for one (1) second.
  (Time modified by AT command.)

The XStream module responds by sending an **OK<CR>**.

All AT commands are sent as follows:

AT	**+**	**Two (2) Character ASCII Command**	**+**	**Optional Space**	**+**	**Parameter (HEX)**	**+**	**Carriage Return**

The ASCII command consists of AT followed by two alphanumeric bytes, and the parameter is a number represented as ASCII hexadecimal characters (0-9, A-F). The ASCII commands and parameters are not case-sensitive. The optional space can be any non-alpha-numeric character

Multiple AT commands can be entered on one line with a carriage return at the end of the line. Each command must be delimited by a comma (and optional space). The 'AT' prefix is only sent before the first command and should not be included with any subsequent commands in a line. If an error is encountered in the command line, no more commands will be executed and an ERROR message will be reported after the carriage return is sent.

AT Commands (cont.)

After executing a recognized AT command, the module responds with an **OK<CR>**. If an unrecognized command or a command with a bad parameter is received, the module will respond with an **ERROR<CR>.**

A modified AT value is reset upon module power-down unless the WR command is issued to save the parameter to non-volatile memory.

To query the current value of a particular command, send the corresponding AT command without any parameters (carriage return, however, is still sent). The response will be the current value of that command reported as a hexadecimal number.

The following example demonstrates basic AT Command functionality in the XStream module.

Example: This example shows two ways to modify the module. It will change the user-defined Module Address to 1A0D (HEX) and check the current value of the SM command. It will also write the new Module Address to non-volatile memory.

METHOD 1	**SEND**	**RESPONSE**
	+++	**OK<CR>**
	ATDT 1A0D<CR>	**OK<CR>**
	ATSM<CR>	**0 <CR>**
	ATWR<CR> *(write to non-volatile memory)*	**OK<CR>**
	ATCN<CR> *(exit AT Command Mode)*	**OK<CR>**
METHOD 2	**SEND**	**RESPONSE**
	+++	OK<CR>
	ATDT 1A0D, WR, SM, CN<CR>	0<CR>-**SM Value Response from valid command**
	OK<CR>	

Exiting AT Command Mode

There are two ways to exit the AT command mode and return to Idle Mode. If no valid AT commands are received within the time specified by the AT Command Timeout parameter (CT command), the module will return to Idle Mode automatically. Alternatively, the AT command mode can be exited by sending the CN command.

Binary Commands

Binary command bytes are organized as follows:

<Command><Parameters>

1 byte *2 bytes*

When sending a Binary command to the XStream, the **Command byte** must be sent while the CMD pin (Pin 5) is asserted (high). CMD can be de-asserted

Binary Commands (cont.)

100 microseconds after the stop bit from the Command byte has been sent. It does not matter whether CMD is asserted when the **Parameter bytes** are sent. The command will execute when all the parameters associated with the command have been sent. During Binary Command execution, CTS will de-assert (high) to show when the command is executing. If all parameters aren't received within 0.5 seconds the module will return to Idle Mode.

Note: When parameters are sent, they are always two bytes long with the Least Significant Byte sent first. When they are read, they are 1 or 2 bytes long as indicated in the "XStream Commands" table (Appendix E) on page 44.

Binary Command Mode allows multiple commands to be sent in sequence. When the CMD pin is asserted, all incoming serial data will be interpreted as commands. Commands can be sent in sequences of commands and their associated parameters. If CMD remains asserted, all received commands will be executed by the XStream module. All modified parameters must be stored in non-volatile memory by sending the WR command (08H with no parameters) before powering down or resetting the module or the changes will be lost.

Commands can be queried for their current value by sending the command logically ORed with the value 80H (hexadecimal) with CMD asserted. After this binary value is sent (with no parameters) CTS is de-asserted and the current value of the command will be sent back, through the DO pin.

Note: For the XStream module to recognize a Binary command, the RT command must be issued from AT Command Mode to enable binary programming. If binary programming is not enabled, the module will not recognize when the CMD pin is asserted and will therefore not recognize Binary Commands.

Example: This example will set Sleep Mode to the Pin Sleep setting and store the new Sleep Mode value to non-volatile memory. (Again, the RT command must be issued in AT Command Mode to enable binary programming before Binary Command Mode will work.)

Assert CMD	**(Enter command mode.)**
Send bytes:	**(Send SM1 command)**
<01H>	**(Command Byte - SM)**
<01H>	**(Least significant byte of the Parameter Bytes - 01H)**
<00H>	**(Most significant byte of the Parameter Bytes – 00H)**
Send bytes:	**(Send WR command)**
<08H>	**(Command Byte - WR)**
De-assert CMD	**Exit Binary Command Mode**

Networking and Addressing

The XStream modules utilize three levels of addressing to communicate between modules. This networking hierarchy is depicted in Figure 8 below. Only modules with the matching addresses are able to communicate. The three methods of addressing are: Vendor Identification number, Networks, and Module Addresses.

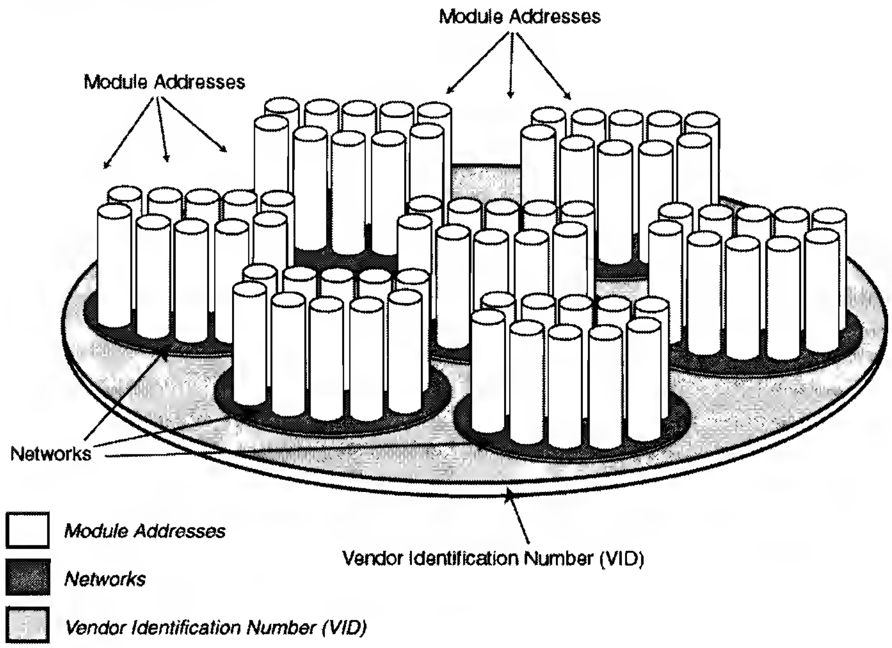


Figure 8 – Layout of a typical network configuration. The XStream features a powerful set of networking and addressing options allowing the functionality of complex networking systems.

Vendor Identification Number (VID)

For network security, a unique **Vendor Identification Number (VID)** can be requested. The VID is programmed into the XStream module at the factory and is stored in permanent memory. This number can only be changed at the factory. Only modules with matching VID numbers can communicate together. VID addressing ensures that modules with a given VID are immune to either transmissions or receptions with XStream modules of a different VID in the same vicinity. To request a unique VID number, contact MaxStream to obtain a **VID Request Form**.

Networks

Within each VID, there are seven available **networks**. Each network utilizes a different pseudo-random hopping sequence to navigate through the shared hopping channels. In the event that two modules from different networks collide on a channel (because they hop in a different sequence) the two modules will jump to separate channels on the next hop. Using networks, multiple module pairs can operate in the same vicinity with minimal interference from each other. The network parameter is user-definable using the HP command as described in the "XStream Command" table (Appendix E) on page 44.

Module Address

Module Addresses and **Module Address Masks** provide another level of addressing among XStream modules. Each module in a network can be configured with a 16-bit Module Address to establish selective communications within a network. This address is set to one of 65535 values using the "DT" command. The default Module Address is 0000H.

All modules with the same Module Address can transmit and receive data among themselves. Any modules on a network with different Module Addresses will still detect and listen to the data in order to maintain network synchronization. However, they will not send the data out to their serial ports if their Module Addresses don't match the Module Address of the transmitter. (The Module Address Mask can be used to provide exceptions to this rule as described in the following section, "Module Address Mask".)

Module Address Mask

The Module Address Mask can be used as an additional method to facilitate communication among modules. The Module Address Mask can also be set to one of 65535 possible values using the MK command. The default value is FFFFH.

All transmitted data packets contain the **Module Address** of the transmitting module. When a transmitted packet is received by a module, the **Module Address** of the transmitter (contained in the packet) is logically "ANDed" (bitwise) with the **Module Address Mask** of the Receiver. If the resulting value matches the **Module Address** of the Receiver, or if it matches the Receiver Module Address Mask, the packet is accepted. Otherwise, the packet is discarded.

Note: When performing this comparison, any "0" values in the Receiver Module Address Mask are treated as *Irrelevant* values and are ignored.

Module Address Mask (cont.)

Packets with a Transmitter Module Address of FFFFH are received by all modules (as shown below in Figure 9). A Transmitter Module Address that matches the Module Address Mask is called a Global Address.

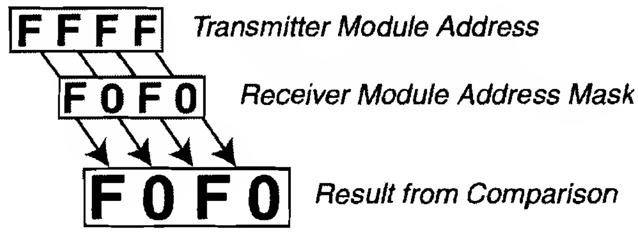


Figure 9 – Demonstration of Module Address comparison at receiver. FFFFH logically "ANDed" with any Module Address Mask will equal the Module Address Mask.

Example: Consider Module A with Module Address of 00FFH and Module Address Mask F0F0H (Figure 10).

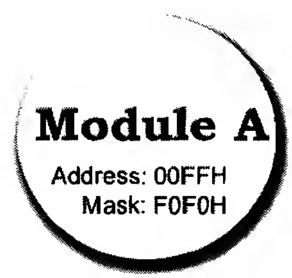


Figure 10

Module A can receive packets from other modules in three ways:

1. **From modules with a Transmitter Module Address of 00FFH.**
2. **By logically "ANDing" a F0F0H Mask with the Receiver Module Address to receive *0XFX* (HEX).**
3. **From an address that matches the Module Address Mask of the module (F0F0H), or packets from a module having a Transmitter Module Address (Global Address) of *FXFX* (since the two *0* values in FOFOH are *insignificant*).**

Acknowledged Delivery

The XStream module can be configured to resend packets until an acknowledgement is received from the destination module. To achieve this functionality, the RR and RN parameters must be set on all radios in the network. The RR parameter determines the maximum number of retries (from 0 to 255) to be sent in the event of packet failure, and the RN parameter specifies the maximum number of delay slots to insert if an acknowledgement is not received. On the receiver module(s), the RR parameter must be set to a non-zero value for an acknowledgement to be sent out when a packet is received.

When an acknowledgement is not received after sending a packet, a random number of delay slots will be inserted (from 0 to RN-1), where each delay slot lasts 38 ms. Thus, if multiple modules were attempting to transmit data at the same time, this will allow one of the modules to re-transmit while the other is delayed. After the transmitter waits for the specified number of delay slots, the transmitter will attempt to re-transmit the packet. This process repeats until the packet acknowledgement is received, or until the packet has been re-sent the number of times specified by RR.

Full Duplex

Full-Duplex configuration monitors the transmission time of an XStream transmitter and inserts occasional delays to allow other modules time to transmit, thus simulating a full-duplex system. In addition, packet acknowledgement is implemented to reduce data loss due to collisions. To configure a full-duplex system, the RR, RN and TT parameters must be set to a non-zero value on all modules operating in the network. The TT parameter specifies the number of continuous bytes that can be transmitted before inserting a delay and the RN parameter specifies the maximum number of delay slots to insert once 'TT' continuous bytes have been transmitted. (Each delay slot lasts 38ms.) The RR parameter must also be set on all modules to enable packet retries if the transmitter fails to receive an acknowledgement. Thus, any packets that are not transmitted successfully will be re-transmitted up to the number of times specified by RR.

Once these parameters have been set, a random number of delay slots (from 1 to RN) will be inserted once a transmitter has sent 'TT' bytes of continuous data.

Glossary

AT commands – A set of commands that can be used to customize and configure the XStream module to meet specific needs. AT commands are sent via a serial communications program such as HyperTerminal.

Binary commands – A set of commands used to configure the XStream module. Binary commands are sent with RTS/CMD asserted. The RT command must be used to enable binary programming prior to using binary commands. Multiple Binary commands can be issued sequentially while RTS/CMD is asserted.

Clear to send – See **$\overline{\text{CTS}}$ pin**.

CMOS logic – Logic levels used by the XStream module (0-5V).

Command Byte - First byte sent when executing a Binary Command. This byte identifies which command will be executed.

Command Mode – A mode of operation, which manually modifies the configurable parameters of the XStream module. Both Binary and AT command modes are available.

Command table – Table containing 28 currently implemented commands. This table lists all of the adjustable parameters along with a brief description of each.

CRC – See **Cyclic Redundancy Check**.

$\overline{\text{CTS}}$ pin – The low-asserted **Clear To Send** pin (Pin 1) provides flow control for the XStream module. When $\overline{\text{CTS}}$ is asserted (low), serial data can be sent to the module for transmission. If the module is unable to transmit the data, $\overline{\text{CTS}}$ may de-assert (high) once the DI buffer nears capacity to prevent buffer overflow.

Cyclic redundancy check (CRC) – Used by the XStream module to ensure data integrity during transmission. A CRC is computed on the bits to be transmitted over-the-air and sent with each data packet. The CRC is recomputed by the receiver and compared with the original CRC bits. The packet is valid if the receiver CRC matches the CRC computed by the transmitter.

Cyclic sleep – Sleep Mode setting in which the module enters a low-power state and awakens periodically to determine if any transmissions are being sent.

DI buffer – Collects incoming serial data prior to over-the-air data transmission. The DI buffer can hold up to 132 bytes at a given time. When the buffer fills to 115 bytes, the Clear To Send ($\overline{\text{CTS}}$) pin is de-asserted to stop the flow of incoming serial data.

Data packets – A grouping of data to be sent over-the-air. Each data packet contains a header and data that is collected from the DI buffer. The size of the packets varies up to 64 bytes depending on how many bytes of data are in the DI buffer.

Glossary *(cont.)*

Data validity – Comparison of received data with transmitted data to ensure accurate transmission. Data validity is verified by performing a CRC check.

DI pin – All incoming serial data enters the XStream module on the Data In (DI) pin (Pin 4).

DO pin – All received over-the-air data leaves the XStream module through the Data Out (DO) pin (Pin 3). The data can then be sent to a microcontroller or RS-232 device.

FCC – The Federal Communications Commission is the US government agency responsible for regulating radio communications standards in the United States.

Flow control – Method of determining when serial data can be sent to the module for over-the-air transmission. Flow control is used to prevent buffer overflow. This can be implemented in hardware and/or software. Hardware flow control is implemented in the XStream module using the $\overline{\text{CTS}}$ pin.

Frequency Hopping Spread Spectrum (FHSS) – Method employed by the XStream module which involves transmitting data over several different channels in a specific channel hopping sequence known by the transmitter and the receiver(s).

Half-duplex – A mode for radio operations. Radios that operate in half-duplex are able to either transmit data or receive data at a given time, but cannot do both simultaneously. When one module is transmitting, all modules (of the same VID and network) within range listen to the transmission and will only transmit once the transmission is complete.

Hardware flow control – See **Flow Control**.

Headers – Information that prefaces the data bits in transmitted data packets. The header contains information used by the receiver(s) to synchronize to the transmitter.

HyperTerminal – A serial communications program useful for communicating with the XStream module and configuring user-defined operating parameters through AT commands.

Idle Mode – A mode of operation in which the module is neither transmitting nor receiving.

Industrial Temperature – Temperature tested version of XStream modules extending beyond normal operating specifications (0°C to 70°C). These modules are tested for a temperature range from -40°C to 85°C.

Glossary *(cont.)*

Integration – The process of incorporating the XStream module into an application in place of a serial cable.

Interface board – An optional board available with the XStream module that converts RS-232-level data into CMOS logic levels and supplies regulated 5V to the module.

Long header – A long header (length determined by LH command – see Appendix E) sent out to ensure that modules running in a cyclic sleep mode detect the header when they awake and synchronize to the transmission.

Low-power modes – See **Sleep Mode**.

Module Addresses – Provides a layer of addressing among modules. Modules with the same Module Addresses can communicate together.

Module Address Masks – Provide a layer of filtering to over-the-air data packets that are received by the module. Thc address (of the transmitting module) is logically "ANDed" with the Module Address Mask of the receiver. The resulting value must match the Module Address of the receiver for the packet to be received. All **"0"** values are not compared.

Networks – Provides a layer above Module Addresses for communicating between modules. Each network has a unique hopping sequence that allows modules on the same network to remain synchronized together.

Parameter Byte – Two bytes sent during a Binary Command following the Command Byte. These bytes are used to set the value of the command specified by the Command Byte. The Least Significant Byte is sent first followed by the Most Significant Byte.

Pin layout – Describes the layout and functionality of all pins on the XStream modulc.

Pin sleep – A Sleep Mode setting which puts the XStream into a minimal power state when the SLEEP pin is asserted. It remains in Pin sleep until the SLEEP pin is de-asserted. This setting must be enabled using the SM command.

Power-saving modes – See **Sleep Mode**.

Receive Mode – A mode of operation that receives over-the-air data and transmits all valid data packets out to the serial port. The module must be in Idle Mode to transition to Receive Mode.

RF – Radio Frequency

RS-232 logic – Standard logic levels implemented in devices using the RS-232 communication protocol.

Glossary (cont.)

RTS/CMD (Request to Send/Command) – The RTS/CMD pin (Pin 5) is used primarily to configure Binary commands (CMD). RTS flow control is not implemented in the XStream module.

Sensitivity – A measurement specification that describes how weak a signal can be (in dBm) and still be detected by the receiver.

Serial data – Data that enters the XStream module through its serial port.

Serial port sleep – A Sleep Mode setting in which module runs in a low power state until data is detected on the DI pin. This setting must be enabled using the SM command.

Sleep Mode – A mode of operation in which the XStream enters a low power consuming state. Several Sleep Mode settings are available and can be configured using the SM command.

SLEEP pin – If Pin Sleep is enabled, the SLEEP pin (Pin 2) determines if the module is in Sleep Mode or Idle Mode. See **Pin sleep**.

Standby Mode – See **Idle Mode**.

Start bit – A low UART signal sent to signify the beginning of an eight-bit data sequence.

Stop bit – The last bit in a UART data sequenee. The stop bit is high and indicates the end of an eight-bit data sequence.

Synchronization – Synchronization is used to ensure that the transmitter and receiver are communicating properly with each other and following the same channel hopping sequence.

Transmission Latency – Time required to send a packet of data. This value is dependent on the number of bytes being sent and the baud rate of the module.

Transmit Mode – Mode of operation in which over-the-air data can be transmitted from a module to other modules.

TTL (Transistor-transistor logic)

VID (Vendor Identification number) – This number allows modules with the same VID to communicate. Any module with a different VID will not receive their data transmissions.

Application Notes

Why does Sensitivity Matter?

Receiver sensitivity is the lowest power level at which the receiver can detect a wave and demodulate data. Sensitivity is purely a receiver specification and is independent of the transmitter. As the wave propagates away from the transmitter, it attenuates as the distance increases. Lowering the sensitivity on the receiver (making it more negative) will allow the radio to detect weaker signals, and can thus increase the transmission range. Sensitivity is vitally important since even slight differences in receiver sensitivity can account for large differences in the range. To better understand this relationship, the following example is provided.

Example: **Compare the MaxStream 9XStream module (with-110 dBm sensitivity) to a commercial radio receiver with a sensitivity of –90 dBm. The Friis transmission formula can be used to calculate received power (or signal strength) at any receiver location under line-of-sight conditions. This formula is given by**

$$P(r) = \frac{P(t) \times G(t) \times G(r) \times \lambda^2}{F(s) \times 4\pi r^2}$$

P(r) = received power (mW)
P(t) = transmitted power (mW)
G(t) = gain of transmit antenna (linear)
G(r) = gain of receive antenna (linear)
F(s) = fading margin (linear)
λ = wavelength (meters)
r = distance between Transmitter and Receiver (meters)

The following values were used to compare the range limitations of these modules:

P(t) = 100mW
G(t) and G(r) = 2dB, or 1.585 linear
λ = 0.333 meters at 900 MHz
F(s) = 21 dB, or 125.89 (experimentally determined)

The table below demonstrates the power received at the receiver over the specified range between the TX and RX antennas, assuming line-of-sight conditions.

Range (meters)	Received Power	Detectable by 9XStream module	Detectable by commercial radio
100	-68.526 dBm	YES	YES
500	-82.506 dBm	YES	YES
1000	-88.526 dBm	YES	YES
3000	-92.048 dBm	YES	NO
5000	-102.506 dBm	YES	NO
8000	-106.588 dBm	YES	NO
10000	-108.526 dBm	YES	NO
11265 (7 miles)	-109.559 dBm	YES	NO
12000	-110.805 dBm	NO	NO

Since the range doubles every 6dB, the 20dB sensitivity difference in radios corresponds to 2^(20/6) = 10.08 times the range using the MaxStream radio!

In a similar fashion, MaxStream radios offer 32 times the range of –80 dBm radios and over 100 times the range of –70 dBm radios.

How Does the 'SY' Command Affect Packet Transmission?

Demonstration 1 – Byte Transmission

Two 19200-baud 9XStream wireless modules were configured with the sync timer command (SY) set to 2 seconds (20 tenths of a second = 14H) and the transmission times were observed. One byte was sent when the modules were out of sync and was followed (within 2 seconds) by a second byte. Figure A1 shows the observed results from the oscilloscope. The pulse on the transmitter is shown at the top of and the pulse on the receiver is shown at the bottom of each plot.

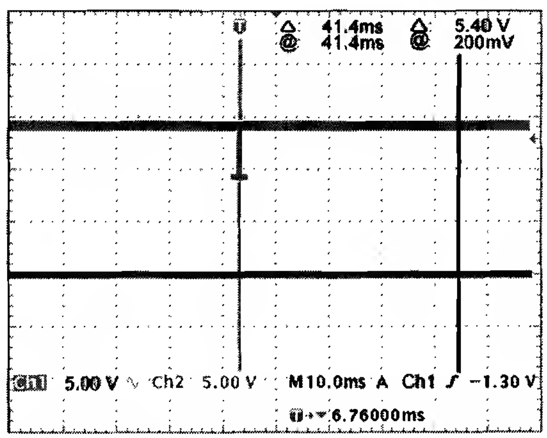


Figure A1

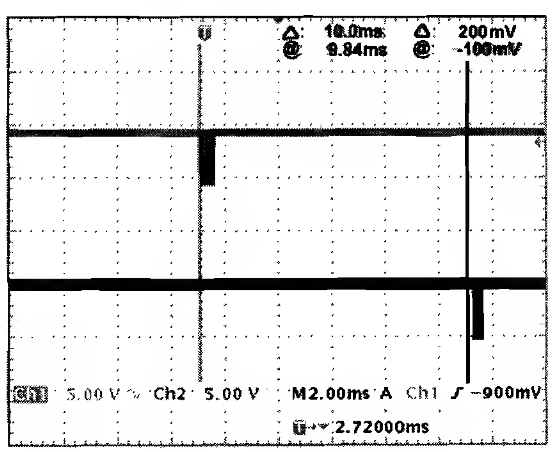


Figure A1 – Oscilloscope output of first byte on transmit and receive ends.

Figure A2 – Oscilloscope output of second byte with SY set to 14H.

Figure A2

From Figures A1 and A2, it is evident that the sync timer parameter can save significant amounts of time by reducing the header length.

As shown in Figure A1, the first byte, which included synchronization information in the header, was sent and received in 41.4 ms. Once the modules were synchronized, the second byte transmission did not have the synchronization information included in the header. This transmission occurred in only 10.0 ms – a savings of about 75%. This is shown on similar testing on the 9600-baud modules showed 48.4 ms to transmit the first byte and synchronize the modules, and 16.2 ms to transmit the second byte without synchronization information. This demonstration was followed by a second test to note the effect of the sync timer command on transmitting a continuous data stream.

Demonstration 2 – Data Transmission

A continuous stream of 32 byte packets was sent to the 9XStream transmitter through a serial connection and then transmitted to a 9XStream receiver located several feet away. This demonstration was performed using 19200-baud modules.

The transmission time was first measured with the modules in their default condition, and then measured again after setting the sync timer (SY command) to 2 seconds (20 tenths of a second = 14H). The following output plots were obtained from an oscilloscope. Again, the pulse on the transmitter is shown at the top of each plot and the pulse on the receiver is shown at the bottom.

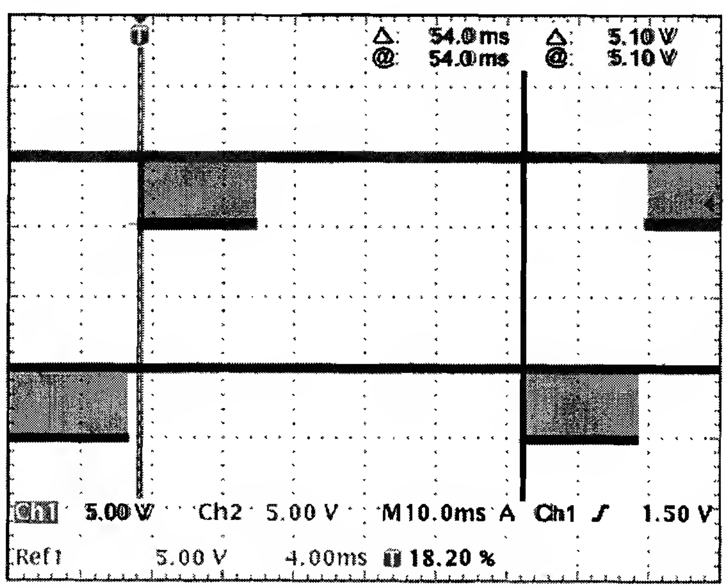


Figure B1 – Oscilloscope output of transmitted and received

under normal conditions.

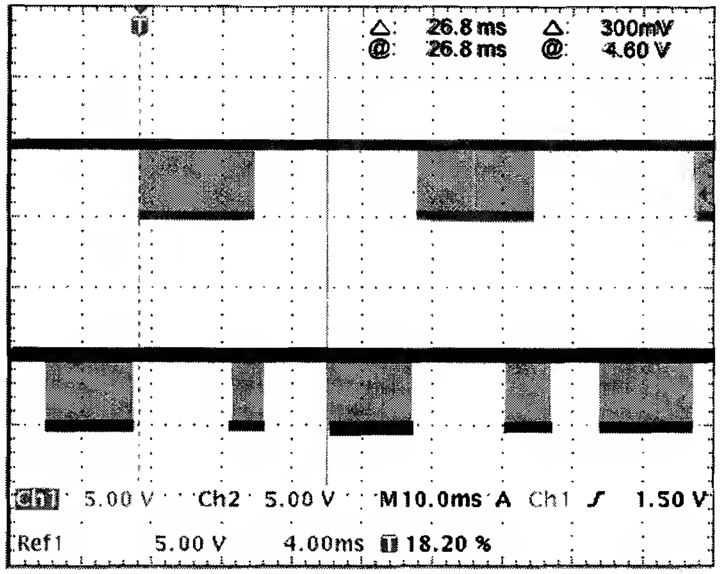


Figure B2 – Plot of transmitted and received data after setting the SY parameter to 14H.

In Figure B1, where synchronization information was transmitted with the data, 54.0 ms was required to transmit each packet to the receiver. After adjusting the SY parameter to stop sending synchronization information in the preamble, Figure B2 shows that the same data transmission occurred in only 26.8 ms.

Appendix A – J1/J2 Pin Descriptions

Pin No.	Pin Name	I/O Type	Description	Active
1	$\overline{\text{CTS}}$	O PU	Clear to Send flow control	low
2	SLEEP (PWRDN)	I PU*	Can be used to enter Sleep Mode (See "Modes of Operation" section for details.)	high
3	DO (Data Out)	O PU	Data leaving the module that is sent to the host	high
4	DI (Data In)	I	Data entering the XStream module to be transmitted over the air	high
5	$\overline{\text{RTS}}$/CMD	I PD	Command mode enable (See "Binary Command Mode" section for details.)	high
6	$\overline{\text{RESET}}$	I PU	Reset module	low
7	RXLED	O	Indicates good RF data reception	high
8	$\overline{\text{TX}}$/PWR	O	PWR - Indicates module powered on	high
			$\overline{\text{TX}}$ - Asserted during transmission	↓ low
9	$\overline{\text{CONFIG}}$	I PU*	Hold low during power up or reset - forces ASCII command mode. DO NOT TIE TO MICROPROCESSOR! (See "Serial Port Operation" section for details.)	low
10	VCC	I	+5 VDC	-
11	GND	-	Signal ground	-

PU – 10kΩ Pull-Up Resistor
PD – 10kΩ Pull-Down Resistor

* $\overline{\text{CONFIG}}$ and $\overline{\text{SLEEP}}$ signals have a 47kΩ Pull-Up Resistor

J2 Pin Descriptions

Pin	Signal
1	GND
2	GND
3	GND
4	GND

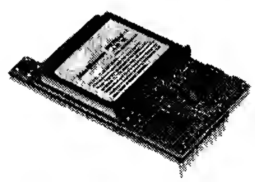
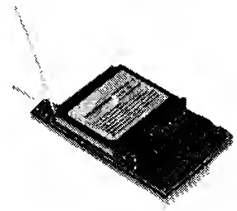
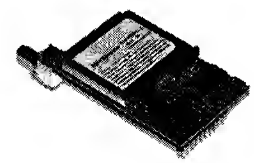
Appendix B – 9XStream Specifications

	X09-009	X09-019
General		
Frequency Range	902 to 928 MHz, unlicensed ISM Band	
Type	Frequency Hopping Spread Spectrum Transceiver	
Frequency Control	Direct FM	
Transport Protocol	Various Monitoring and Addressing Modes – *see "Networking and Addressing" section*	
Channel Capacity	Hops through 25 channels. Features 7 different hop sequences.	
Serial Data Interface	Asynchronous CMOS (TTL) signals, 5V levels	
Serial Interface Baud Ratc	Configurable from 2400-57600 bps **1200 bps available*	Configurable from 2400-57600 bps
Data Throughput	9600 bps	19200 bps
Performance		
Channel Data Rate	10k	20k
Transmit Power Output	100mW	100mW
Rx Sensitivity	-110 dBm	–107 dBm
Range*	Indoor: 600' to 1500' Outdoor: 7mi. with dipole, over 20 mi. with high gain antenna	Indoor: 425'to 1060' Outdoor: 5 miles with dipole, over 14 miles with high gain antenna
Interference Rejection	70 dB at pager and cellular phone frequencies	
Power Requirements		
Supply Voltage	5 VDC +/-0.25V	
Current Consumption	Tx – 150 mA nominal, Rx – 50 mA nominal Power Down mode – less than 1 microamp Other cyclic power-down modes available – *see "Low Power Modes" section*	
Physical Properties		
Board Size	1.6" x 2.825" x .35" (4.06 x 7.18 x .89) cm	
Weight	0.8oz (24g)	
Connectors	11 pin and 4 pin 0.1" spaced male Berg type headers	
Operating Temperature	Standard: 0°C to 70°C Industrial version: -40°C to 85°C available	

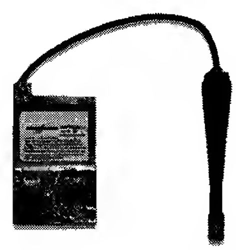
Appendix C – 24XStream Specifications

	X24-009	X24-019
General		
Frequency Range	2.40 to 2.4835 GHz, unlicensed ISM Band	
Type	Frequency Hopping Spread Spectrum Transceiver	
Frequency Control	Direct FM	
Transport Protocol	User Transparent. Various Monitoring and Addressing Modes – *see "Networking and Addressing" section*	
Channel Capacity	Hops through 25 channels (international version) or 75 channels (US version). Features 7 different hop sequences.	
Serial Data Interface	Asynchronous CMOS (TTL) signals, 5V levels	
Serial Interface Baud Rate	Configurable from 2400-57600 bps	Configurable from 2400-57600 bps
Data Throughput	9600 bps	19200 bps
Performance		
Channel Data Rate	10k	20k
Transmit Power Output	50 mW	50 mW
Rx Sensitivity	-104 dBm	-101 dBm
Range*	Indoor: 150' to 375' Outdoor: 1.4mi. with dipole, over 12 miles with high gain antenna	Indoor: 106' to 265' Outdoor: 1 mi. with dipole, over 8.5 miles with high gain antenna
Power Requirements		
Supply Voltage	5 VDC +/-0.25V	
Current Consumption	Tx – 240 mA nominal, Rx – 70 mA nominal Power Down mode –1 µA Other cyclic power-down modes available – *see "Sleep Mode" section*	
Physical Properties		
Board Size	1.6" x 2.825" x .35" (4.06 x 7.18 x .89) cm	
Weight	0.8oz (24g)	
Connectors	11 pin and 4 pin 0.1" spaced male Berg type headers	
Operating Temperature	Standard: 0°C to 70°C	

Appendix D – Product Listing

MMCX – No Antenna	MMCX – Wire Antenna	SMA – No Antenna
X09-009NM, X09-019NM	X09-009WMC, X09-019WMC	X09-009NSC, X09-019NSC
X09-009NMI, X09-019NMI	X09-009WMI, X09-019WMI	X09-009NSI, X09-019NSI
X24-009NMC, X24-019NMC	X24-009WMC, X24-019WMC	X24-009NSC, X24-019NSC
X24-009NMI, X24-019NMI	X24-009WMI, X24-019WMI	X24-009NSI, X24-019NSI



¼ Wave Antenna MMCX
A09-QBMM-3-P6I

½ Wave Antenna MMCX
A09-HBMM-7-P6I

½ Wave Antenna SMA
A09-HASM-675

900 MHz Modules - Parts List

Product Code	Description
X09-009NMC	9600-baud, no wire mount antenna, MMCX connector
X09-009WMC	9600-baud, wire mount antenna, MMCX connector
X09-009NSC	9600-baud, no wire mount antenna, SMA connector
X09-019NMC	19200-baud, no wire mount antenna, MMCX connector
X09-019WMC	19200-baud, wire mount antenna, MMCX connector
X09-019NSC	19200-baud, no wire mount antenna, SMA connector
XH9-009NMC	9600-baud, no wire mount antenna, MMCX connector, Australia/Israel Ver.
XH9-009WMC	9600-baud, wire mount antenna, MMCX connector, Australia/Israel Version
XH9-009NSC	9600-baud, no wire mount antenna, SMA connector, Australia/Israel Version
XH9-019NMC	19200-baud, no wire mount antenna, MMCX connector, Australia/Israel Ver.
XH9-019WMC	19200-baud, wire mount antenna, MMCX connector, Australia/Israel Version
XH9-019NSC	19200-baud, no wire mount antenna, SMA connector, Australia/Israel Version
X09-009NMI*	9600-baud, no wire mount antenna, MMCX connector
X09-009WMI*	9600-baud, wire mount antenna, MMCX connector
X09-009NSI*	9600-baud, no wire mount antenna, SMA connector
* *Industrial Temperature Rating*	

900 MHz Modules (cont.)

Product Code	Description
X09-019NMI*	19200-baud, no wire mount antenna, MMCX connector
X09-019WMI*	19200-baud, wire mount antenna, MMCX connector
X09-019NSI*	19200-baud, no wire mount antenna, SMA connector
Package Kits	
X09-009PKC	9600-baud, Package
X09-019PKC	19200-baud, Package
X09-009PKI*	9600-baud, Package
X09-019PKI*	19200-baud, Package
Development Kits	
X09-009DKC	9600-baud, Development Kit
X09-019DKC	19200-baud, Development Kit
* *Industrial Temperature Rating*	

2.4 GHz Modules – Parts List

Product Code	Description
X24-009NMC	9600-baud, no wire mount antenna, MMCX connector
X24-009WMC	9600-baud, wire mount antenna, MMCX connector
X24-009NSC	9600-baud, no wire mount antenna, SMA connector
X24-019NMC	19200-baud, no wire mount antenna, MMCX connector
X24-019WMC	19200-baud, wire mount antenna, MMCX connector
X24-019NSC	19200-baud, no wire mount antenna, SMA connector
X24-009NMI*	9600-baud, no wire mount antenna, MMCX connector
X24-009WMI*	9600-baud, wire mount antenna, MMCX connector
X24-009NSI*	9600-baud, no wire mount antenna, SMA connector
X24-019NMI*	19200-baud, no wire mount antenna, MMCX connector
X24-019WMI*	19200-baud, wire mount antenna, MMCX connector
X24-019NSI*	19200-baud, no wire mount antenna, SMA connector
* *Industrial Temperature Rating*	
Package Kits	
X24-009PKC	9600-baud, Package
X24-019PKC	19200-baud, Package
X24-009PKI*	9600-baud, Package
X24-019PKI*	19200-baud, Package
Development Kits	
X24-009DKC	9600-baud, Development Kit
X24-019DKC	19200-baud, Development Kit
* *Industrial Temperature Rating*	

Appendix E – XStream Commands

AT Command	Binary Command Number	Description	Parameters	# Bytes Returned	Factory Default
DT	0	Set the Module Address. (Only modules with the same address can communicate.)	Range: 0 – FFFFH	2	0
SM	1	Adjust Sleep Mode Setting	0 - No Sleep 1 – Pin Sleep 2 – Serial Port Sleep 3 – Cyclic 0.5 second 4 – Cyclic 1.0 second 5 – Cyclic 2.0 second 6 – Cyclic 4.0 second 7 – Cyclic 8.0 second 8 – Cyclic 16.0 second	1	0
ST	2	Set time to Sleep. Time of inactivity before entering Sleep Mode (This number is only valid in Cyclic and Serial Port Sleep settings).	Range: 10H – FFFH (tenths of a second)	2	64H
HT	3	Set time before long header. Time of inactivity (no serial or over-the-air data is transmitted or received) before a long header is used. The default value (FFFFH) means no long header will be sent.	Range: 0 – FFFFH (tenths of a second)	2	FFFF H
BT	4	Set silence time before command sequence.	Range: 0 – FFFFH (tenths of a second)	2	AH
AT	5	Set silence time after command sequence.	Range: 0 – FFFFH (tenths of a second)	2	AH
CT	6	Set time out from AT Command Mode. Returns to Idle Mode from AT Command Mode if no valid commands have been received within this time period.	Range: 0 – FFFFH (tenths of a second)	2	C8H
FL	7	Set serial software flow control. (Hardware flow control (CTS) is always on.)	0- No software flow control 1- use software flow control	1	0

Appendix E – XStream Commands (cont.)

AT Command	Binary Command Number	Description	Parameters	# Bytes Returned	Factory Default
WR	8	Write all configurable parameters to non-volatile memory. All settable parameters are stored.	NA	NA	NA
CN	9	Exit AT Command Mode.	NA	NA	NA
E0	10	No echo in AT command mode.	NA	NA	NA
E1	11	Enable character echo in AT command mode.	NA	NA	NA
LH	12	Transmit header time. Used to adjust the length of the long header.	Range: 0 – FFH (tenths of a second)	1	1H
FH	13	Force header on next transmit.	NA	NA	NA
RE	14	Restore defaults configuration.	NA	NA	NA
ER	15	Set Receive Error Count. This value is reset to 0 after every reset. It is not non-volatile. Once this counter reaches FFFFH, it remains there until reset.	Range: 0 – FFFFH	2	0
GD	16	Set Receive Good Count. This value is reset to 0 after every reset. It is not non-volatile. Once this counter reaches FFFFH, it remains there until reset.	Range: 0 – FFFFH	2	0
HP	17	Set Network number. Each Network uses a different hop sequence. Seven different Network numbers are available. This can be used to operate independent networks of XStream modules in the same vicinity.	Range: 0 – 6	1	0

Appendix E – XStream Commands (cont.)

AT Command	Binary Command Number	Description	Parameters	# Bytes Returned	Factory Default
MK	18	Set Module Address Mask. Only bits set to '1' are used in the address comparison between the transmitter's address and that of the receiver. A global address is an address that has the same bits set as the Address Mask.	Range: 0 – FFFFH	2	FFFFH
CC	19	Set command sequence character. The parameters determine the ASCII command sequence character uscd to enter AT Command Mode.	Range: 20H – 7FH	1	2BH ('+')
VR	20	Firmware version	NA	2	NA
BD	21	Set Serial Baud Rate (bps). Use to adjust the serial port baud rate. The new baud rate will not take effect until the ATCN command is issued. If the BD command is issued in Binary Command Mode, it must be stored using the WR command, and the new baud rate will take affect after resetting the module.	Range: 1 - 6 1 - 2400 2 - 4800 3 - 9600 4 - 19200 5 - 38400 6 - 57600	1	
RT	22	RTS/CMD Control. This command must be used to turn on binary programming if Binary Command Mode will be used. (By default, binary programming is disabled, so any commands sent in Binary Command Mode will not be understood until binary programming is enabled.)	0 – Disable binary programming. 1 – Enable binary programming 2 – Enable RTS flow control	1	0

Appendix E – XStream Commands (cont.)

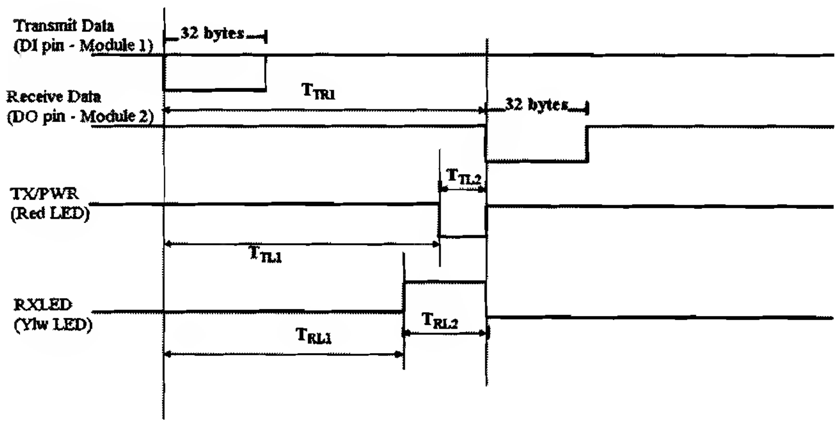
AT Command	Binary Command Number	Description	Parameters	# Bytes Returned	Factory Default
SY	23	Set Sync Timer. This time represents the time that the transmitter and receiver stay in sync after receiving or sending data. Setting this parameter to 20 (14H) will allow any module to transmit within the next 2 seconds utilizing a header of 8ms instead of 35ms. Use this parameter to speed up communication latency and turn-around time.	Range: 0 –FFH (tenths of a second)	1	0
RR	24 V4.22	Selects number of retries for a sent packet. Retries are not implemented when RR is set to '0'. All modules in a network must have RR set to a non-zero value for retries to work correctly.	Range: 0 – FFH	1	0
RN	25 V4.22	Maximum number of delay slots that can be inserted after failure of an acknowledge packet. (Each delay slot is 38 milliseconds long.) No delay slots will be inserted if RN is set to '0'.	Range: 0 – FFH	1	0
TT	26 V4.22	Number of bytes to transmit before inserting a random delay up to "RN" delay slots. No delays will be inserted if TT is set to '0'.	Range: 0 – FFFFH	2	FFFFH
TR	27 V4.22	Records the number of retransmit failures.	Range: 0 – FFFFH	2	0
RS	28 V4.22	Return signal level of last received packet.	NA	1	0
PW	29 V4.22	Allow pin wake up from Cyclic Sleep Mode.	0 – No pin wake up. 1 – Pin wake up enabled during cyclic sleep	1	0

Appendix E – XStream Commands (cont.)

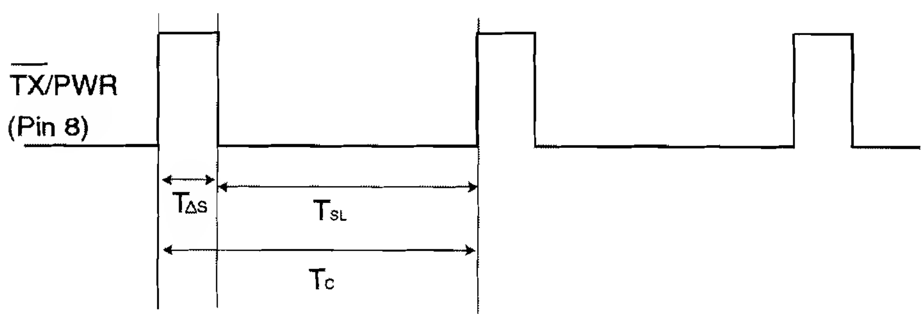
AT Command	Binary Command Number	Description	Parameters	# Bytes Returned	Factory Default
PC	30 V4.22	Enable power-up to ASCII mode. (Allows modem DTR emulation.)	0 – Module enters data mode on power mode. 1 – Module enters Command Mode on power up or from Sleep Mode.	1	0
CS	31 V4.22	Change CTS signal from flow control to RS-485/422 transmit enable.	0 – CTS flow control. 1 - CTS is the RS-485/422 transmit enable signal.	1	0

Appendix F – Timing Diagrams

Pin Timings



Cyclic Sleep Mode Timings



Appendix G – 9XStream Electrical Characteristics

DC Characteristics
(Vcc=4.75V to 5.25V)

Symbol	Parameter	Condition	Min	Typical	Max	Units
V_{IL}	Input Low Voltage	All input signals	-0.5		0.3*Vcc	V
V_{IH}	Input High Voltage	(Except $\overline{\text{RESET}}$)	0.6*Vcc		Vcc+0.5	V
V_{IH2}	Input High Voltage	($\overline{\text{RESET}}$)	0.9*Vcc		Vcc+0.5	V
V_{OL}	Output Low Voltage	I_{OL}=20mA Vcc=5V			0.6	V
V_{OH}	Output High Voltage	I_{OH}=-3mA Vcc=5V	4.2			V
I_{IL}	Input Leakage Current I/O Pin	Vcc=5V, pin low (abs. value) (Except $\overline{\text{CTS}}$, DO, $\overline{\text{RESET}}$, $\overline{\text{CONFIG}}$)			8.0	uA
I_{IH}	Input Leakage Current I/O Pin	Vcc=5V, pin high (abs. value) (Except RTS/CMD)			980	nA
I_{IL2}		$\overline{\text{CTS}}$, DO, $\overline{\text{RESET}}$		$(Vcc-V_I)/10$		mA
I_{IL3}		$\overline{\text{CONFIG}}$		$(Vcc-V_I)/47$		mA
I_{IH2}		$\overline{\text{RTS}}$/CMD		$V_I/10$		mA

Appendix G – 9XStream Electrical Characteristics (cont.)

AC Characteristics
Pin Timings (SY=0)

Symbol	Description	X09-019	19200 Timing* (B = Number of Bytes)	X09-009	9600 Timing* (B = Number of Bytes) (T measured in ms)
T_{TR1}	Latency from the time data is transmitted until received.	54 ms	For 0<B<64, T=41.6+(0.4*B) For B>63, T=66.8 ms	72.0 ms	For 0<B<40, T=46.27+(0.73*B) For B>=39 bytes, T=74.8 ms
T_{TL1}	Time from when data packet is transmitted until TX/PWR first pulses low.	46.4 ms	For 0<B<12, T=37.8 ms For 11<B<65, T=33.3+(0.39*B) ms For B>64, T=58.4 ms	55.6 ms	For 0<B<12, T=39.8 ms For 11<B<35, T=30.52+(0.77*B) For B>34 bytes, T=56.8 ms
T_{TL2}	Time that TX/PWR pin is driven low (when red LED flashes).	8.4 ms	For 0<B<14, T=3.24+(0.4B) For B>13, T=8.48 ms	16.8 ms	For 0<B<14, T=6.5+(0.8*B) ms For B>13, T=16.8 ms

AC Characteristics
Pin Timings (SY=0) (cont.)

Symbol	Description	X09-019	19200 Timing* (B = Number of Bytes)	X09-009	9600 Timing* (B = Number of Bytes) (T measured in ms)
T_{RL1}	Time from when data packet is transmitted until RXLED pin first goes high on receiver.	40.6 ms	For all B, T=39.6 ms	44.5 ms	For all B, T=44.5 ms
T_{RL2}	Time that RXLED pin is driven low (when yellow LED flashes).	13.6 ms	For 0<B<65, T=0.79+(0.408*B) For B>64, T=26.9 ms	25.6 ms	For 0<B<37, T=1.63+(0.794*B) For B>36, T=30.2 ms
* Note: The timing formulas are approximations over a specified range of bytes. They are accurate to within 1 – 2 milliseconds.					

Pin Timings (SY = 10)

Symbol	Description	X09-019	19200 Timing Formulas* (B = Number of Bytes)	X09-009	9600 Timing Formulas* (B = Number of Bytes) (T measured in ms)
T_{TR1}	Latency from the time data is transmitted until received.	12.2 ms	For 0<B<9, T=9.0+(0.4*B) For B>8, T=12.2 ms	19.4 ms	For 0<B<6, T=15.5+(0.775*B) For B>5 bytes, T=19.4 ms
T_{P3}	Time duration of CRC bits in data packet.	0.83 ms	For all B, T=0.8 ms	1.6 ms	For all B, T=1.6 ms
T_{TL1}	Time from when data packet is transmitted until TX/PWR first pulses low.	6.04 ms	For all B, T=6.04 ms	9.08 ms	For all B, T=9.08 ms
T_{TL2}	Time that TX/PWR pin is driven low (when red LED flashes).	6.44 ms	For 0<B<9, T=3.24+(0.4*B) For B>8, T=6.44 ms	11.3 ms	For 0<B<6, T= 6.5+(0.8*B) ms For B>5, T=11.3 ms
T_{RL1}	Time from when data packet is transmitted until RXLED pin first goes high on receiver.	8.44 ms	For all B, T=8.44 ms	14 ms	For all B, T=14 ms
T_{RL2}	Time that RXLED pin is driven low (when yellow LED flashes).	4.28 ms	For 0<B<10, T 0.8+(0.4*B) For B>9, T=4.28 ms	5.68 ms	For 0<B<6, T=1.6+(0.82*B) For B>5, T=5.68 ms
* Note: The timing formulas are approximations over a specified range of bytes. They are accurate to within 1 – 2 milliseconds.					

Cyclic Sleep Mode Timings

Symbol	Description	19200-baud	9600-baud
$T_{\Delta S}$	Time when module is listening for a valid header to start receiving data.	100 ms	100 ms
T_{SL}	Time where the XStream is in its low power cyclic sleep. This time is adjustable using the SM command.	0.5 seconds 1.0 seconds 2.0 seconds 4.0 seconds 8.0 seconds 16.0 seconds (depends on SM)	0.5 seconds 1.0 seconds 2.0 seconds 4.0 seconds 8.0 seconds 16.0 seconds (depends on SM)

Cyclic Sleep Mode Timings (cont.)

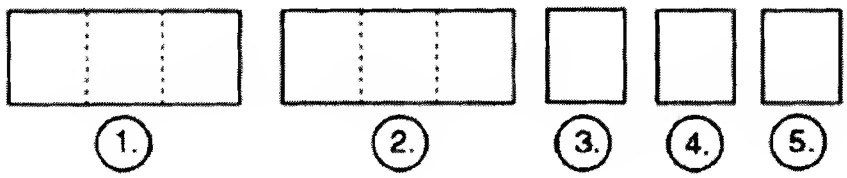
Symbol	Description	19200-baud	9600-baud
T_C	Total period between successive pulses of the module awakening from Sleep Mode. This value is dependent on the setting of the SM command.	0.6 seconds 1.1 seconds 2.1 seconds 4.1 seconds 8.1 seconds 16.0 seconds (depends on SM)	0.6 seconds 1.1 seconds 2.1 seconds 4.1 seconds 8.1 seconds 16.0 seconds (depends on SM)

Appendix H – 9XStream Sleep Mode Settings Table

Setting	Usage	Transition to Sleep Mode	Return to Idle Mode	Configure Commands
Pin Sleep (SM=1)	Use Pin Sleep to achieve lowest power consuming state (<1μA). Gives host device complete control over when the module is active or in sleep state. Consumes 1mA of current.	Assert (high) SLEEP pin.	De-assert (low) SLEEP pin.	SM
Serial Port Sleep (SM=2)	Use Serial Port Sleep to wake the module once data arrives on the serial port.	Automatic transition after user-defined period of inactivity (no transmitting or receiving). Set by ST command.	Any serial byte received on DI pin.	SM, ST
Cyclic Sleep (SM=3-8)	Use Cyclic Sleep for one module to contact a sleeping module via the air interface. The sleeping module will periodically check for incoming packets and awake when one is detected. Several settings allow flexibility with tradeoffs of latency and average power draw. The module can be configured such that it will be forced into an active state when SLEEP pin is de-asserted (low).	Periodically returns to Idle Mode. Can be forced into Idle Mode using SLEEP pin if PW command is issued.		SM, ST, LH, HT, PW.

Appendix I – Module Part Numbers

Module Part Numbers Key



1. Operating Frequency
   - **X09** - 900 MHz
   - **X24** - 2.4 GHz
   - **XH9** - Australia and Israel 900MHz frequencies
2. Over-Air Baud Rate
   - **009** - 9600-baud
   - **019** - 19200-baud
3. Wire Antenna
   - **W** - Wire Antenna
   - **N** - No Wire Antenna
4. Connector
   - **M** - MMCX Connector
   - **S** - SMA Connector
   - **N** - No Connector
5. Temperature Rating *Recommended*
   - **C** - Commercial. Certified for operation from 0° to 70° C.
   - **I** - Industrial. Conformal coated. Recommended for operation from -40° to 85° C.
   - **T** - 100% Tested. Conformal coated. Certified for operation from -40° to 85° C.

Troubleshooting and FAQs

- Several on-line support features are available. Please see the following links for additional help. If your answer is not found here, contact technical support at support@MaxStream.net.
- **FAQs -**
  http://www.maxstream.net/support_faq.html
- **Discussion Forum -**
  http://www.maxstream.net/support_discussionforum.html
- **Documentation -**
  http://www.maxstream.net/support_documentation.html

Index

XStream™ Wireless OEM Modules

Long RANGE
Low POWER
Low COST
&
Advanced
NETWORKING

Visit
www.maxstream.net
to download all documents
published by MaxStream, Inc.

Part no. MD0002 (v3.0)